

Late Pliocene to Early Pleistocene donaciine fossils from the Uonuma Formation (Part II): A new *Donacia* from the Uonuma hills in Niigata Prefecture, Japan (Coleoptera: Chrysomelidae: Donaciinae)

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新潟県中越地方の魚沼層から産出した後期鮮新世—前期更新世の
ネクイハムシ亜科の化石（その2）：魚沼丘陵産の*Donacia* 属の1新種

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抄録：新潟県魚沼丘陵の魚沼層から4種のネクイハムシ化石を記録した。魚沼層の時代は後期鮮新世から中期更新世初頭（約2.3-0.7Ma）にわたるが、ほとんどの化石は鮮新世末期から前期更新世のものである。この中で、新種*Donacia uedana* sp. nov. ウオヌマヒラタネクイハムシを記載し、2つの特徴的な化石の産状について報告した。

Abstract. Four species of donaciine fossils were recorded from the Uonuma Formation in the Uonuma hills, Niigata Prefecture. The age of the formation in the hills ranges from Late Pliocene to earliest Middle Pleistocene (ca. 2.3-0.7Ma), while ages of most fossils are latest Pliocene to Early Pleistocene. Among them, *Donacia uedana* was described as a new species, and two unusual cases were reported in the mode of fossil occurrence.

Key words: Donaciinae; *Donacia uedana*; extinct species; fossil; new species; Pliocene; Pleistocene; Uonuma Formation

This paper reports on the donaciine fossils from the Plio-Pleistocene Uonuma Formation following Hayashi (1999). As a result of survey from 1998 to 1999, abundant donaciine fossils were found in the formation at the Uonuma and Higashikubiki hills in Niigata Prefecture. I recognized four species including a new *Donacia* from these fossils.

The objectives of the present papers are to describe a new species *Donacia uedana* and other donaciine fossils from the Uonuma formation, and to reexamine my previous work. In addition, two unusual cases in the mode of occurrence of *D. uedana* are also discussed.

This study followed the method of Hayashi (1999). All fossil specimens reported in this paper are deposited in the Osaka Museum of Natural History (OMNH). For comparison, recent specimens from both in OMNH and in author's collection were used.

Contributions from the Osaka Museum of Natural History, No. 367(Accepted March 9, 2000)

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Geological setting

The Plio-Pleistocene Uonuma Formation is widely distributed in the Higashikubiki and the Uonuma hills, southern part of the Niigata sedimentary basin, and attains more than 2,000m in the total thickness. The formation contains many characteristic volcanic ash layers which are useful for correlation (Fig. 1). The litho- and tephro-stratigraphic studies of the formation were carried out in detail by Uonuma Hills Collaborative Research Group (1983), Yanagisawa et al. (1985), Kazaoka et al., (1986), Kazaoka (1988), Kobayashi et al. (1989), Kurokawa and Miura (1993), and Kurokawa et al. (1993). The formation is correlated with the Osaka Group in the Kinki region and the Kazusa Group in Boso Peninsula based on correlation of several tephra beds (e.g. Satoguchi et al., 1999). The geologic age of the formation is assigned to the Late Pliocene to earliest Middle Pleistocene (Yoshikoshi, 1983; Muramatsu, 1983; Yoshikawa et al., 1994, 1996). In the Uonuma hills, the Uonuma formation is distributed on the western slope of the hills and is composed of fluvial and marine deposits (Yanagisawa et al., 1985; Kazaoka et al., 1986).

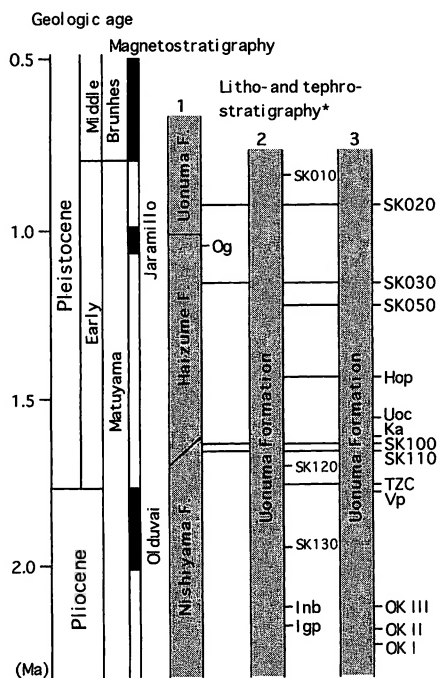


Fig. 1. Litho-, Magneto-, and Tephro-stratigraphy of the Uonuma Formation (modified after Yanagisawa et al., 1985, Kobayashi et al., 1993, and Satoguchi et al., 1999). *1, Nishiyama hills; 2, Higashikubiki hills; 3, Uonuma hills.

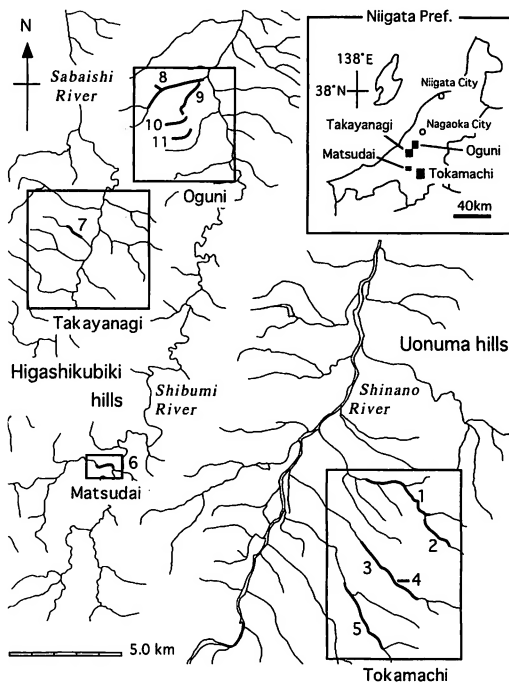


Fig. 2. Index map of the studied area. 1, Tagawa-1 Route; 2, Tagawa-2 Route; 3, Kawajigawa Route; 4, Takinosawa Route; 5, Hanegawa Route; 6, Inubushi Route; 7, Nakakuragawa Route; 8, Shibonomata Route; 9 and 10, Tributary of Shibonomata-gawa Route; 11, Enmagasawa Route.

Fossil localities and stratigraphic horizons

The donaciine fossils reported in this paper were collected from the Uonuma and Higashikubiki hills in the central region of Niigata Prefecture (Fig. 2). I surveyed 11 routes and collected donaciine fossils from 18 localities.

The investigated area of Tokamachi City in the western slope of the Uonuma hills is shown in Figs. 3 and 4. I surveyed five routes of Tagawa River 1 (Route 1), Tagawa River 2 (Route 2), Kawajigawa River (Route 3), Takinosawa River (Route 4) and Hanegawa River (Route 5). The geologic columns of these routes and their correlation are shown in Fig. 5. The Tagawa Route contains 12 characteristic tephra beds of Ooike I (OK I), Ooike III (OK III), Variegated Pumice (Vp), Myogayama TB (My-TB), Tsuiki Gomashio (Tg), SK110, Lapilli zone 2 (Lap. 2), Uonogigawa (Uoc), Lapilli zone 3 (Lap. 3), SK050, SK030 and SK020 in ascending order (Uonuma Hills Collaborative Research Group, 1983; Yanagisawa et al., 1985; Kazaoka et al., 1986). Tsujimatagawa volcanic ash layer (TZC: Kazaoka et al., 1986) between Vp and My-TB, is present in Routes 3 and 4 (Fig. 5).

The formation in the Uonuma hills is mainly composed of alternation of sand and silt but also intercalated with lignite and gravel. Lignite beds include remains of beetle, pupa of Lepidoptera and plant (leaf, seed, fruit etc.). The donaciine fossils were obtained from the lignite beds at the following 11 localities: Ttg7, Ttg8, Ttg9, Ttg12, Ttg13, Ttg16, Tkj10, Tkj13, Ttk1, Ttk2, and Thn5 (Fig. 5).

On the other hand, I obtained donaciine fossils from 7 localities in the Higashikubiki hills, as follows: Min1, Tnk2, Osb9, Ost1, Ost9, Oen1, and Oen3. The geologic columns and their correlation are shown in Fig. 6 (see Hayashi, 1999).

New records, reclassification, and description of a new species

Subfamily Donaciinae Kirby

Genus *Plateumaris* Thomson

Plateumaris constricticollis (Jacoby)

Donacia constricticollis Jacoby, 1885, p. 192, pl., XI, fig. 2. (original description)

Plateumaris constricticollis (Jacoby): Jacobson, 1892, p. 434.

New records and specimens examined. 64 fossil specimens from Min1, Ttg7, Ttg9, Ttg12, Ttg13, Tkj10, Tkj13, Ttk1, Ttk2, and Thn5 (Figs. 5, 6).

Fossil records. Hayashi (1999, p. 8); Hayashi (1999, p.15, recorded as *Plateumaris* sp. A).

Fossil horizon. Lowest to upper member of the Uonuma Formation (the Late Pliocene to the early Middle Pleistocene).

Remarks. In my previous work (Hayashi, 1999), the author has recognized "*Plateumaris* sp. A", yielded from the lower part of the formation, as a different species from the other Japanese congeners, because the pronotal characters seemed to be different. However, after the most features on the abdomen and the hind legs from the formation has been reexamined, it become clear that they undoubtedly correspond to *P. constricticollis*. Since the pronotal

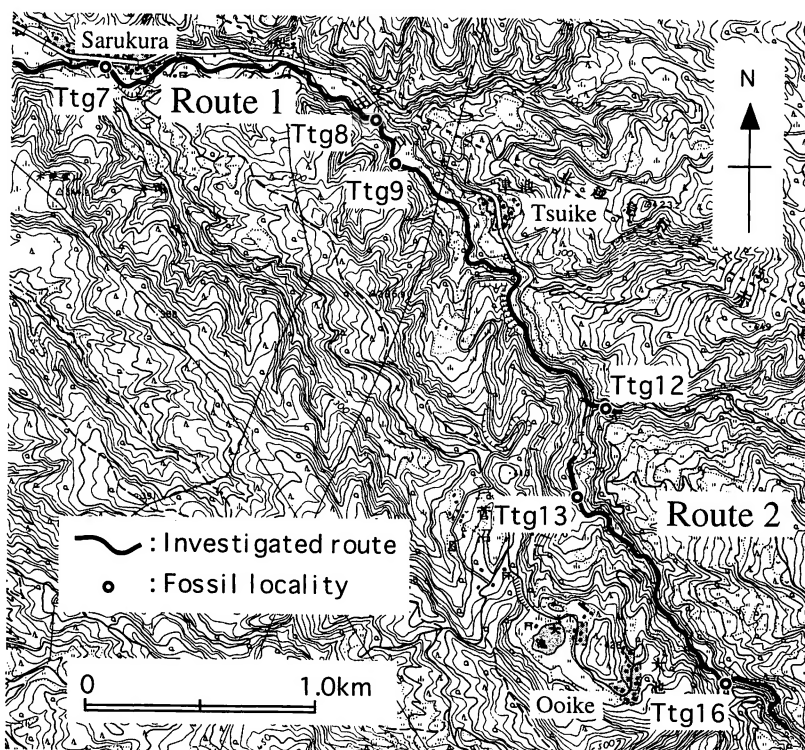


Fig. 3. Locality map of the Routes 1 and 2. Modified from the topographical map "Tokamachi", scale 1: 25,000 by the Geographical Survey Institute.

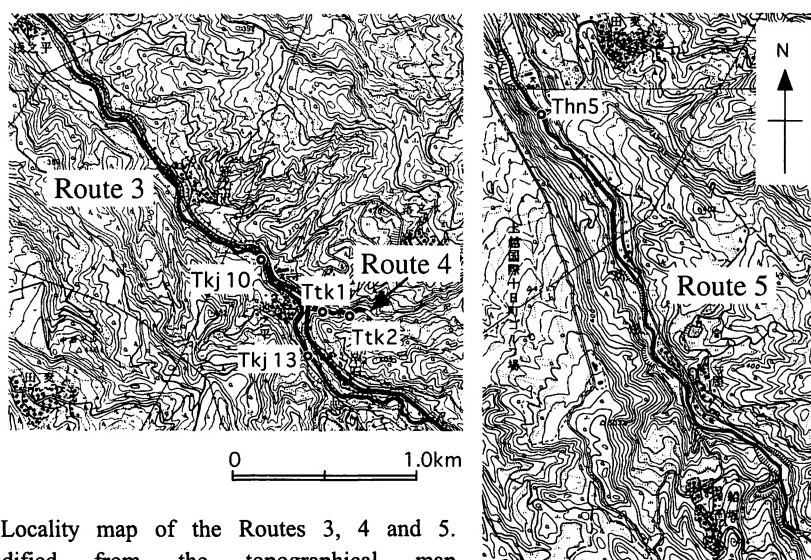


Fig. 4. Locality map of the Routes 3, 4 and 5. Modified from the topographical map "Tokamachi" and "Shiozawa", scale 1: 25,000 by the Geographical Survey Institute.

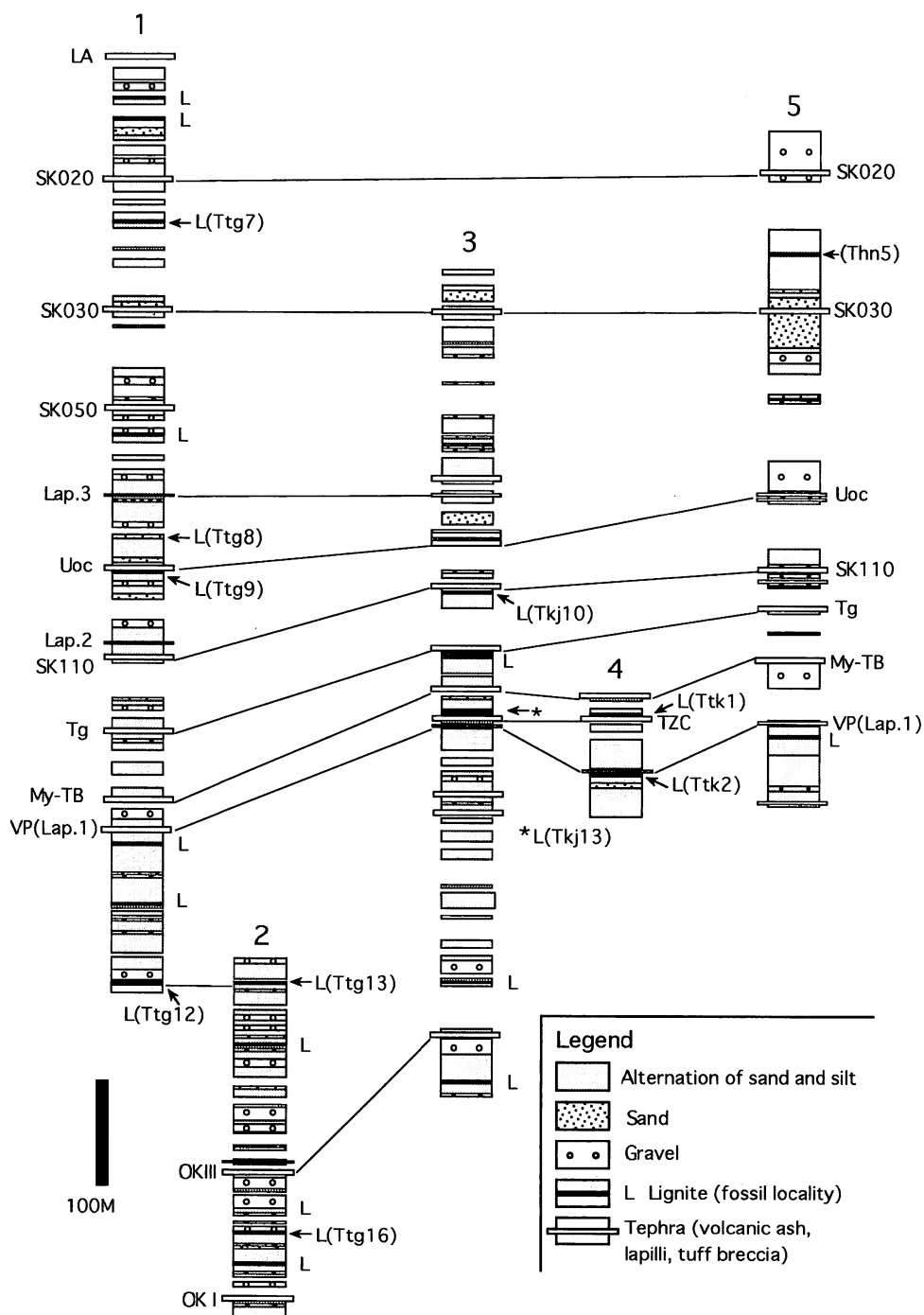


Fig. 5. The geologic columns and fossil horizons at five routes in Tokamachi City. Route numbers refer to Fig. 2.

microsculptures may be variable, this time I identify them as *P. constricticollis*.

Genus *Donaciella* Reitter

***Donaciella nagaokana* Hayashi**

Donaciella nagaokana Hayashi, 1998, p.40, figs.5, 6, 7H (original description).

New record and specimen examined. One fossil specimen from Osb9 (Fig. 6).

Fossil records. Hayashi (1998, p. 40).

Fossil horizon. Lower to upper member of the Uonuma Formation (the latest Late Pliocene to the Early Pleistocene).

Remarks. This species was described from the upper part of the formation at Nagaoka City (Hayashi, 1998). The fossil species had been known only from its type locality before the present record.

Genus *Donacia* Fabricius

Subgenus *Donaciomima* Medvedev

***Donacia (Donaciomima) japana* Chûjô and Goecke**

Donacia japana Chûjô and Goecke, 1956, p. 60, 1fig. (original description)

New record and specimen examined. One fossil specimen from Thn5 (Fig. 5).

Fossil records. Hayashi et al. (1996, p. 112); Hayashi (1999, p. 15).

Fossil horizon. Lower to upper member of the Uonuma Formation (the latest Late Pliocene to the Early Pleistocene).

***Donacia (Donaciomima) vulgaris* Zschach**

(Fig. 7A)

Donacia vulgaris Zschach, 1778, p. 27. (original description)

New record and specimen examined. Two fossil specimen from Tnk2 (Fig. 6).

Fossil records. Hayashi et al. (1996, p.113, recorded as *D. vulgaris*?); Hayashi (1999, p.16, recorded as *D. vulgaris*?).

Fossil horizon. Lower to upper member of the Uonuma Formation (the latest Late Pliocene to the Early Pleistocene).

***Donacia (Donaciomima) uedana* sp. nov.**

(Japanese name: Uonuma-hirata-nekui-hamushi)

(Figs. 7B-D, 8-10, 11A-B, 11E-F, 11K, 12A, 12E)

Donacia (Donaciomima) clavareau?: Hayashi 1999, p. 17, fig. 12-4, *pro parte*.

Diagnosis. The new species can be recognized by legs of entirely metallic green or cupreous, metafemur with a blade-like tooth, pygidial apex truncate in male and entirely rounded in female, pronotal disc coarsely punctate with transverse rugae laterally, median lobe of male genitalia gradually narrowed at apex with a median lip, median process of endophallus short.

Description. Coloration of head, pronotum, elytron, tibia, femur, sterna of thorax and abdomen entirely metallic green or cupreous; pygidium metallic green or cupreous but apical margin and basal part rufous. Vertex densely and coarsely punctate. Pronotal outline more or less quadrate; anterolateral calli present, callosal sulci shallow; disc coarsely punctate with transverse and coarse rugae laterally; basal sulcus present, with dense rugae and puncture; median line continuous. Elytron subparallel-sided from base to middle and gradually narrowed toward apex, with 10 complete punctate striae and a scutellar striole; sutural interval entirely rugose, narrowed apically; other intervals with transverse rugae between them, getting finer and denser apically; apex truncate, inner apical angle nearly right. Metafemur provided with a prominent and blade-like tooth; apical-ventral margin finely dentate in male. Pygidium punctate; apex entirely rounded in female and truncate in male. Sternum of 7th abdominal segment with punctation; apex prominent in female and entirely rounded in male. Male genitalia with median lobe gradually narrowed at apex with a median lip; tegmen slender; median process (median ejaculatory guide + endophallic lateral digit: Askevold, 1990) of endophallus short and arched.

Measurements. Pronotum, length 1.4-1.6mm (n=5); elytron, length 5.7-6.5mm, width 1.8-1.9mm, L:W ratio 3.1-3.4 (n=2); metafemur, length 2.6-2.7mm, width 1.1-1.2mm, L:W ratio 2.3-2.4 (n=2).

Type series. Holotype OMNH-TI-122 and 19 paratypes (in coll. of the Osaka Museum of Natural History, Nagai Park 1-23, Higashi-sumiyoshi-ku, Osaka, 546-0034 Japan).

Other specimens examined. Twenty fossil specimens from Ost1, Oen1, Ttg7, Ttg13 and Thn5.

Type locality and horizon. Thn5 at Hanegawa River, Tokamachi City, Niigata Prefecture, Japan (37° 4' 56" N, 138° 46' 12" E, alt. 250m: Fig. 4). The fossil horizon between SK030 and SK020 (Fig. 5).

Remarks. The subgenus *Donaciomima* Medvedev includes about 50 Palaearctic and 20 Nearctic species (Askevold, 1990, 1991). *D. uedana* is distinguishable from those recent species in apical shape of median lobe and general shape of endophallus of male genitalia (Fig. 11). Most members of the subgenus are recognized by median lobe with obtusely angled apex and a median lip (cf. Fig. 11D), while *D. uedana* is acute angled apex in median lobe. Though some members possess the acute apex (e. g. *Donacia vulgaris*, *D. simplex*, *D. distincta*, *D. subtilis*), they apparently differ from the new species in endophallic and pygidial characters. *D. uedana* may be most similar to a Japanese species, *Donacia hiurai* Kimoto, 1983. Common features are the discal rugae on pronotum and elytra, coloration of legs, shape of metafemoral tooth and the apical shape of pygidium in both sexes (Fig. 12), but the new species differs from *D. hiurai* in the endophallic characters: shape of median process and its general size (Fig. 11).

Etymology. The specific name of the new species is dedicated to the late Dr. Tetsuro Ueda, formerly Niigata University.

***Donacia (Donaciomima) clavareai* Jacobson?**

(Fig. 7E)

Description. Coloration of pronotum and elytron entirely metallic green, sometimes dark blue; femur metallic green in apical half and in rufous basal half; tibia entirely rufous. Pronotal outline more or less quadrate; median line fine; callosal sulcus present, but shallow; disc coarsely punctured, with transverse and shallow rugae; basal sulcus shallow. Elytron subparallel-sided from base to middle and gradually narrowed toward apex, with ten complete punctate striae and a scutellar striole; stria punctures nearly vertical oval; all intervals shiny; sutural interval gradually narrowing to apex, and rugose; other intervals with transverse rugae between them; apex truncate, outer and inner apical corner nearly right angled. Metafemur with a small tooth. Male pygidial apex emarginate.

Measurements. Pronotum, length 1.4-1.6mm (n=2); elytron, length 6.0 mm, width 1.6 mm, L:W ratio 3.8 (n=1); metafemur, length 2.1 mm, width 0.8mm, L:W ratio 2.6 (n=1).

New records and specimens examined. Three fossil specimens from Ost9, Oen3 and Tnk2 (Fig. 6).

Fossil records. Hayashi (1999, p. 17, fig. 13-4).

Fossil horizon. Lower member of the Uonuma Formation (the latest Late Pliocene to the Early Pleistocene).

Remarks. This species is probably identical with *Donacia clavareai* Jacobson, 1906.

During the process of the reexamination, I found that the concept of "*D. clavareai*?" in Hayashi (1999) was a mixture of two species: One possesses femora in metallic green on apical half and coarsely punctate disc on pronotum, and the other possesses femora entirely in metallic green. In this paper, the latter is assigned to the new species, *D. uedana*.

Subgenus *Donacia* Fabricius***Donacia ozensis* Nakane**

Donacia ozensis Nakane, 1954, p. 739. (original description)

New record and specimen examined. Three fossil specimen from Ttg8 (Fig. 5).

Fossil records. Hayashi (1999, p. 17).

Fossil horizon. Lower to middle member of the Uonuma Formation (the latest Late Pliocene to the Early Pleistocene).

Late Pliocene to Early Pleistocene donaciine fauna of the Uonuma Formation

Hayashi (1999) reported nine donaciine species from the formation at the Higashikubiki hills, but "*Plateumaris* sp. A" from the lower member is identified with *Plateumaris constricticollis* based on this reexamination. The formation at the Uonuma hills yields four species including one extinct species: *P. constricticollis*, *Donacia japana*, *Donacia ozensis*, and *Donacia uedana* sp. nov. I recognized ten species including four extinct species from the Late Pliocene to Early Pleistocene donaciine fauna of the Uonuma Formation in total. The

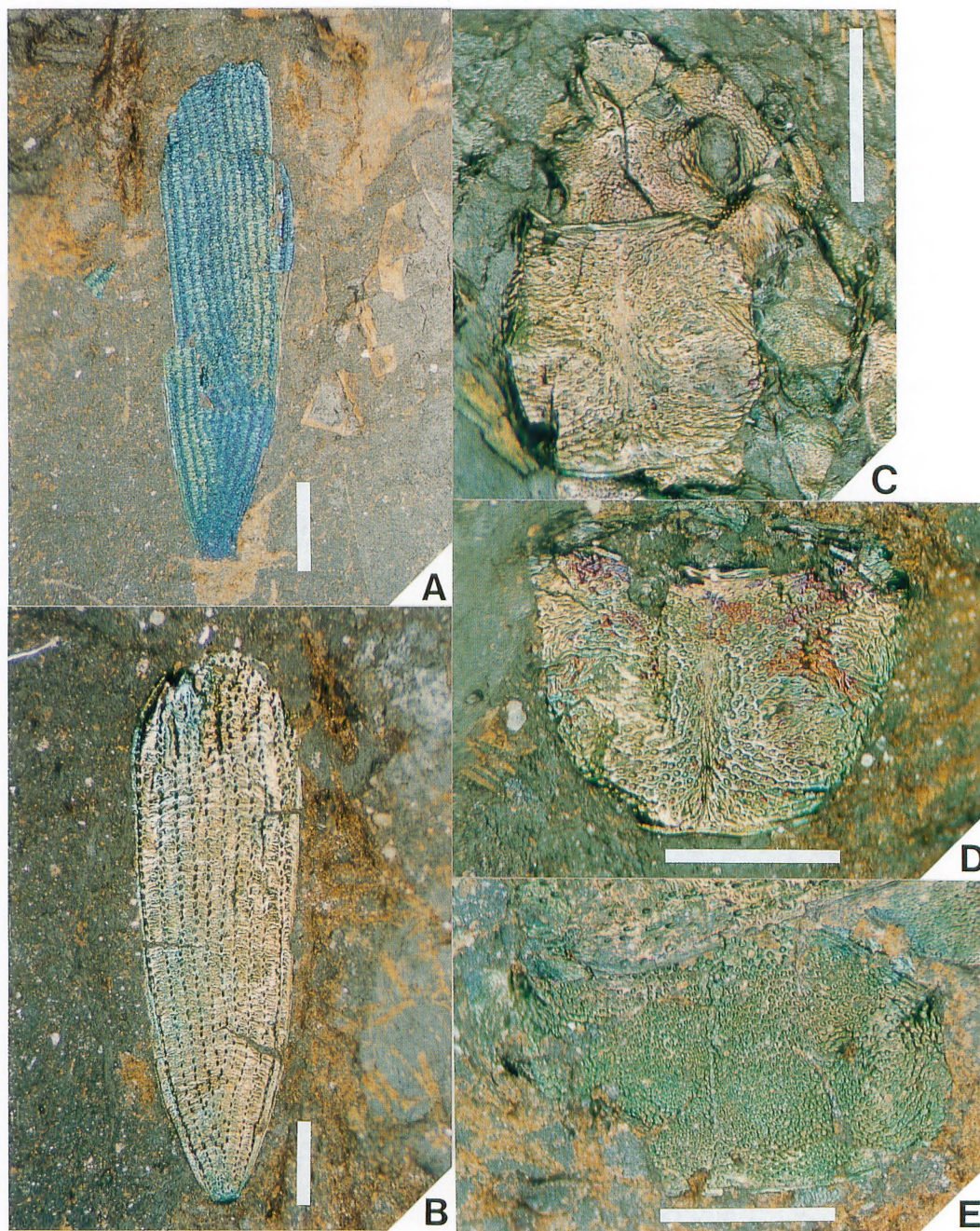


Fig. 7. A, *Donacia vulgaris*, elytra. B-D, *Donacia uedana* sp. nov.: B, left elytron; C, head and pronotum; D, pronotum. E, *Donacia clavareau?* sp. nov., pronotum. scale bars = 1.0 mm.

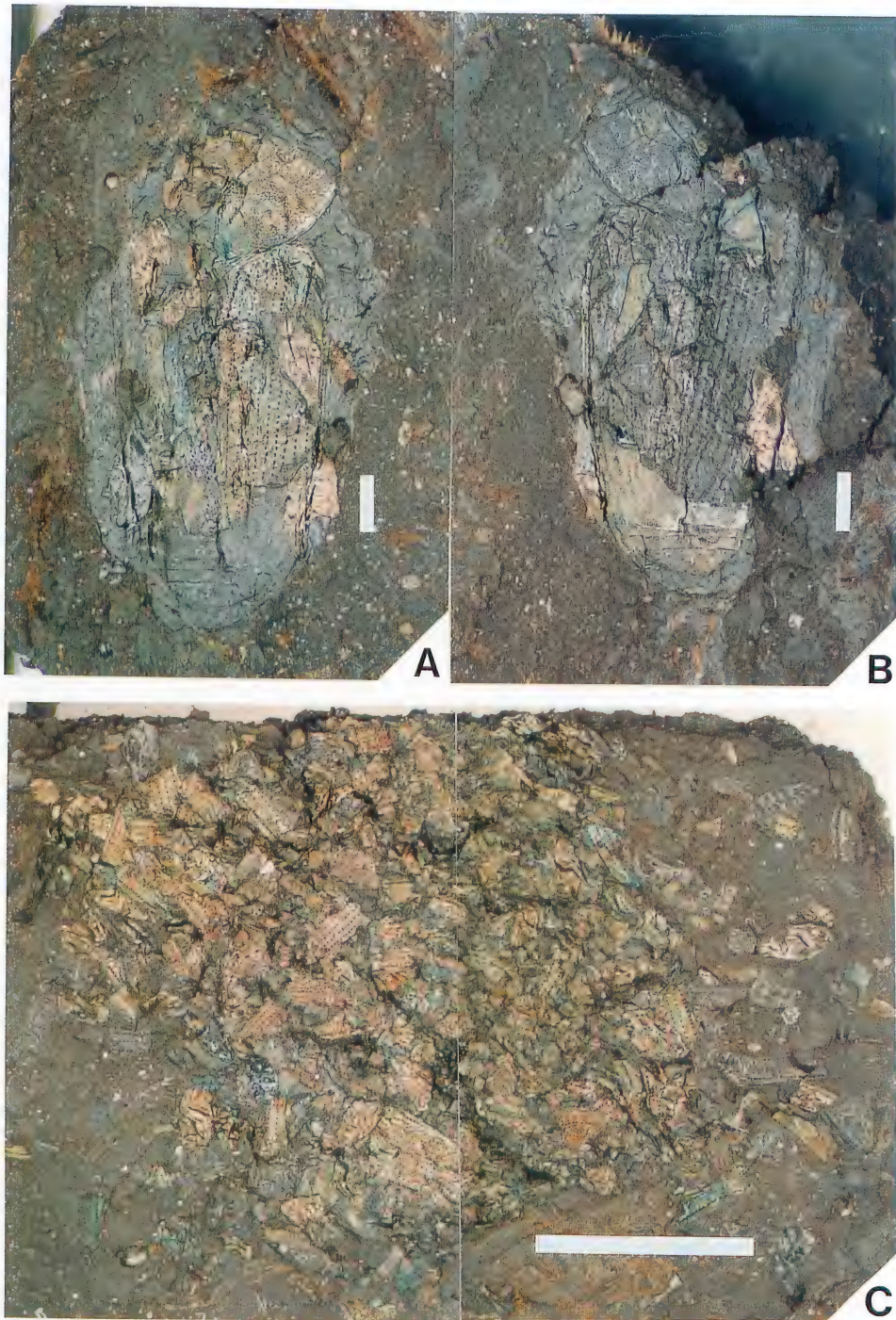


Fig. 8. A-C, *Donacia uedana* sp. nov.: A-B, Holotype (female), part (A) and its counterpart (B). C, A mass of fragmentary segments (in part). Scale bars = 1.0 mm in A and B; 5.0mm in C.

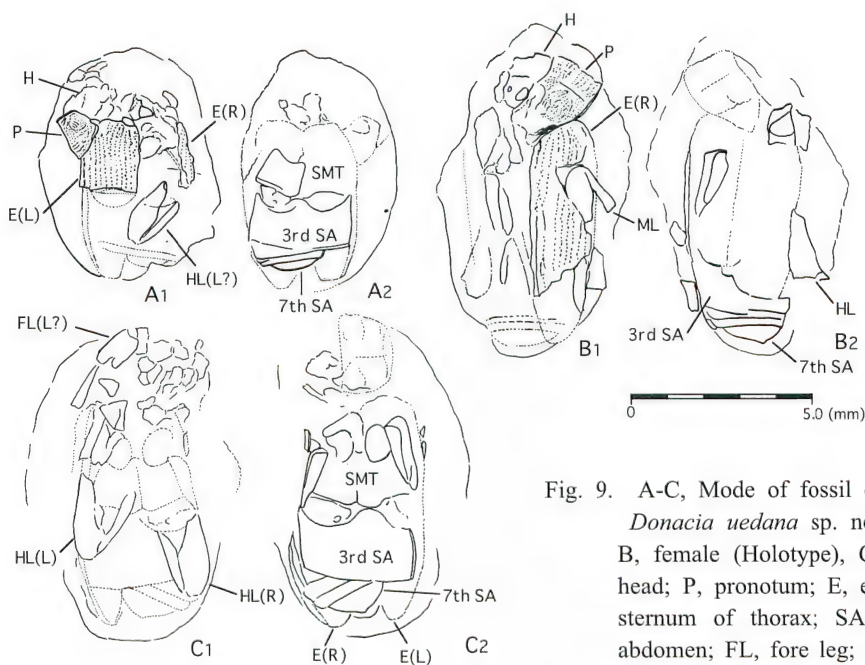


Fig. 9. A-C, Mode of fossil occurrence of *Donacia uedana* sp. nov.: A, male; B, female (Holotype), C, female. H, head; P, pronotum; E, elytron; SMT, sternum of thorax; SA, sternum of abdomen; FL, fore leg; ML, mid leg; HL, hind leg; (R), right; (L), left.

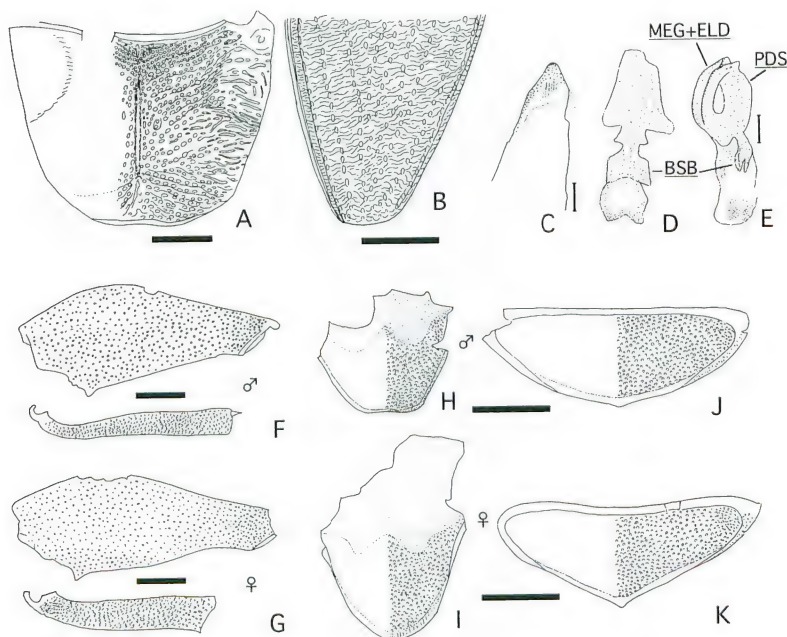


Fig. 10. A-K, *Donacia uedana* sp. nov. A, pronotum. B, apex of right elytron. C-E, male genitalia: C, apex of median lobe; D-E, endophallus (D, dorsal view; E, lateral view from left side). F-G, hind leg: F, male; G, female. H-K, sternum of 7th abdominal segment: H, male; I, female. J-K, sternum of 7th abdominal segment: J, male; K, female.

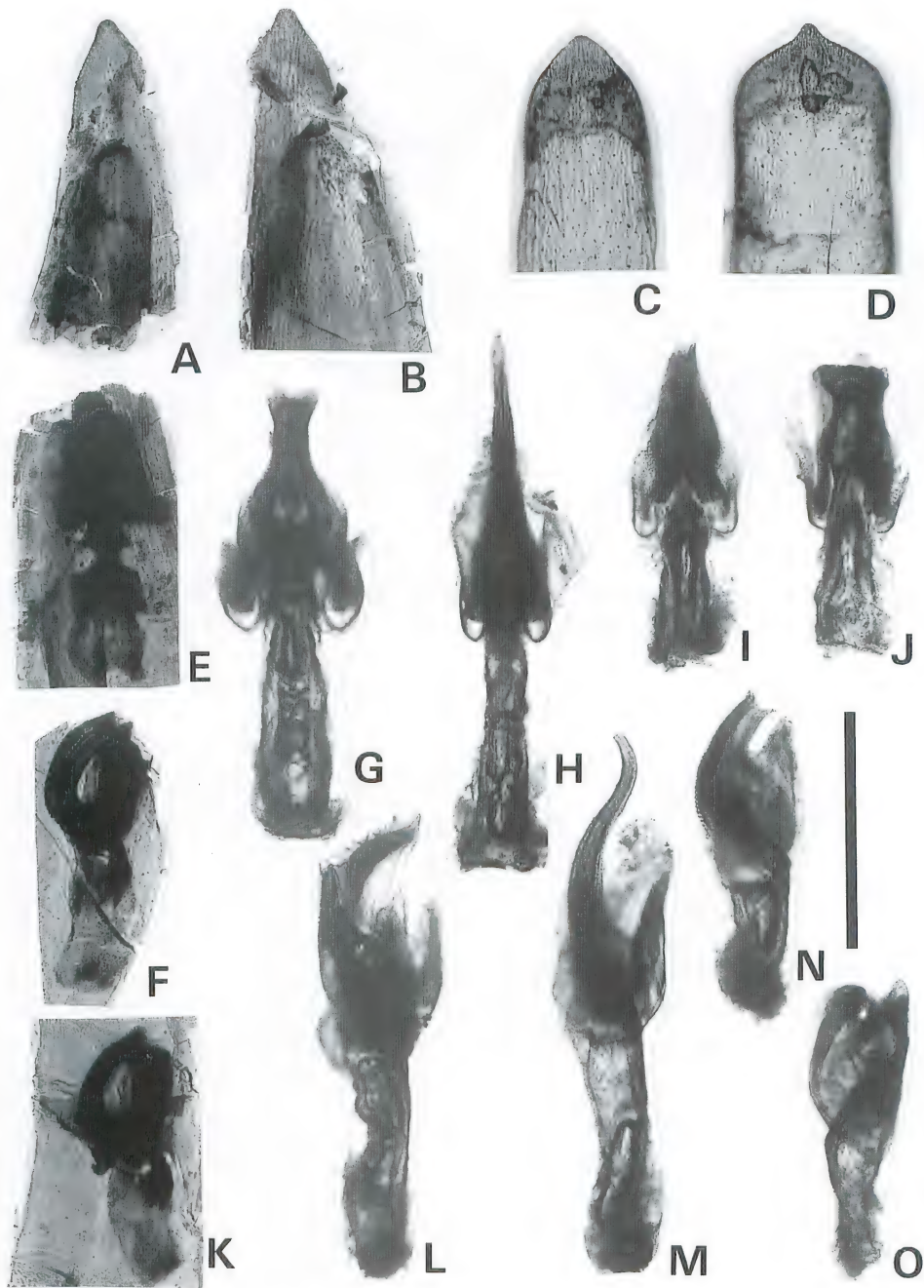


Fig. 11. A-N, Male genitalia of *Donacia* spp. A-D, apex of median lobe. E-O, endophallus: E-J, dorsal view; F-O, lateral view from left side. A, B, E, F, K, *D. uedana* sp. nov. Living specimens: C, G, L, *D. hiurai*; D, H, M, *D. clavareau*; I, N, *D. japana*; J, O, *D. bicoloricornis*. Scale bar = 0.5mm.

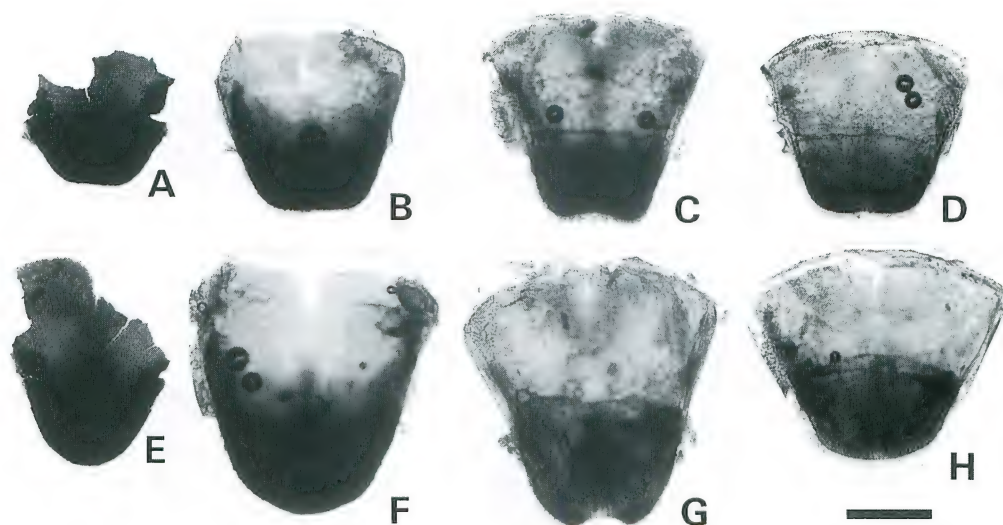


Fig. 12. A-H, Pygidium of *Donacia* spp. A-D, male. E-H, female. A, E, *D. uedana* sp. nov. Living specimens: B, F, *D. hiurai*; C, G, *D. clavareai*; D, H, *D. japana*. Scale bar = 0.5mm.

chronological records of the donaciine fossils are summarized in Fig. 13.

Two unusual cases in the mode of fossil occurrence

The bedding planes of lignite bed at Thn5 contain abundant moderately well-preserved fossils of the new species, *D. uedana*. The lignite at the site is probably sedge peat because it includes herb fibers and fruits of Cyperaceae. In most cases the fossil beetles in the peaty deposits are broken into small body parts or segments. In this study, two new modes of occurrence for *D. uedana* were observed.

In the first case, the main body parts such as head, pronotum, elytra, sterna, or appendages are simultaneously discovered in oval-shaped films, rightly maintaining their relative positions (Figs. 8A-B, 9). It is already known that the donaciine beetles form pupal cocoons at the roots of the host plants, and that the adults often stay in their cocoons for several months after the eclosion (Kanazawa, 1985; Bieńkowski, 1996). In fact, Narita (1989) reports that he has collected adults of the three species, *Donacia vulgaris*, *Donacia hirtihumeralis* and *Plateumaris constricticollis* from pupal cocoons, and I also collected *P. constricticollis* in Funabashi City, Chiba Prefecture on April. Furthermore, Harusawa (1985) reported that he had found a dead adult of *Plateumaris sericea* in a cocoon. Based on these observations, I assume that these fossils were formed in the following process: (1) the beetles accidentally died in the cocoons after eclosion; (2) because the cocoons covered the body of beetles they have been preserved in rather good condition in the sediment; (3) the cocoons transformed into the oval films and continued to keep their body parts together for long terms.

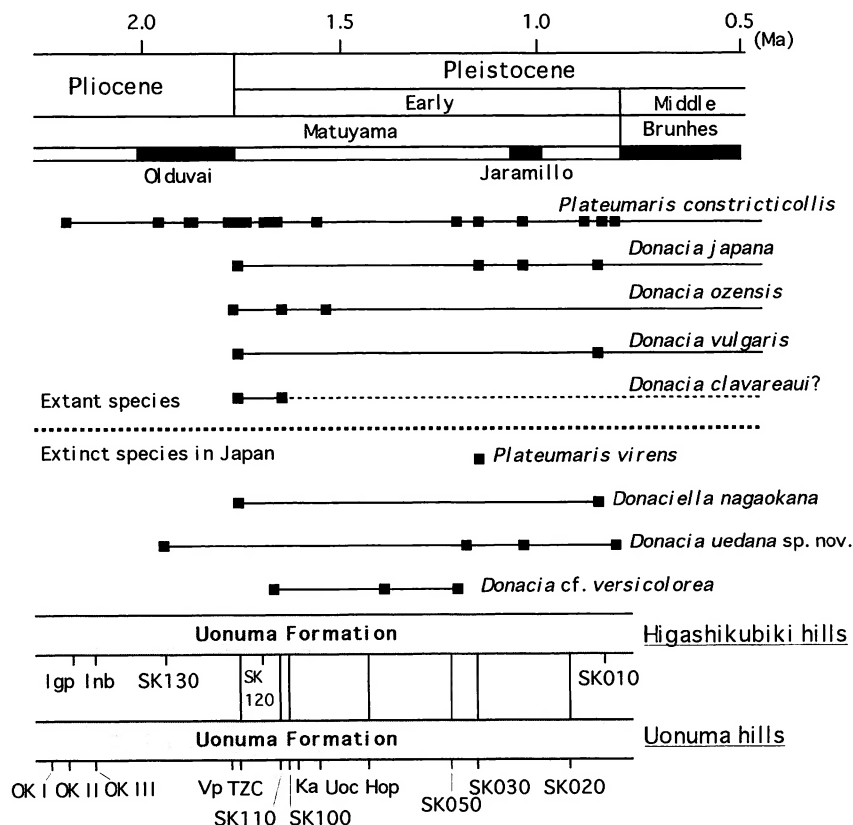


Fig. 13. Fossil records of the donaciine beetles from the Uonuma Formation. Data from Hayashi et al., (1996), Hayashi (1998), Hayashi (1999), and present study.

The second case is that a mass of beetle fragments are discovered at Thn 5 (Fig. 8C). The mass measures 30 mm in length and 15 mm in width. After careful counting and observation I found that it clearly contained several (at least 5) individuals of the beetle species in high density, about 200 fragments/cm². It is clear that the mass has not been formed in normal sedimentary processes. I suppose that the mass is an excrement of some animal and fossilized as follows: (1) many adults of this species were eaten by the predator; (2) the excretion of the predator composed of these fragments, has been preserved in the sediment.

Acknowledgements

I am deeply indebted to Prof. Iwao Kobayashi, Niigata University, for valuable discussions and supporting this study. I am also deeply indebted to Dr. Arata Momohara, Chiba University, for many helpful suggestions on my field survey. I greatly acknowledge to Dr. Eiichi Takazawa, Niigata University, for helpful advice of this manuscript. I also gratefully acknowledge to Mr. Shigehiko Shiyake, Osaka Museum of Natural History for allowing

accesses to the referred materials.

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APPENDIX 地名のローマ字表記

Kawajigawa River (川治川), Hanegawa River (羽根川), Higashikubiki (東頸城), Takinosawa (滝の沢), Tagawa River (田川), Tokamachi City (十日町市), Uonuma (魚沼).